

## Paladin Integrated Management (PIM)

### Executive Summary

- DOT&E approved the Paladin Integrated Management (PIM) Engineering and Manufacturing Development Test and Evaluation Master Plan on March 5, 2012.
- In 1QFY12, PIM completed Phase I government developmental testing with five prototype howitzers and two prototype ammunition carriers. The howitzer reliability estimate from Phase I reliability, availability, and maintainability (RAM) missions was 45 hours Mean Time Between System Abort (MTBSA) compared to a requirement of 62 hours.
- In July 2012, PIM vehicles commenced Phase II developmental testing in preparation for a Limited User Test scheduled for October 31 through November 8, 2012, to support a June 2013 Milestone C decision.
- Testing to characterize the protection provided by M109 Family of Vehicles (FoV) armor configurations began in August 2012 and is scheduled to continue through the end of the year.
- In 2011, DOT&E raised concerns regarding the M109 FoV force protection and survivability requirements. As a result, the Army improved the systems' ballistic vulnerability requirements, and OSD directed the Army to design, develop, and test an underbelly kit to address operationally-relevant underbody blast threats.
- OSD also directed the Army to characterize the expected impact of the objective-level underbelly kit on howitzer performance and vehicle RAM by integrating such a kit into the PIM program's development and testing, and planned Production Qualification Testing.
- The program's current plans are schedule driven, with limited time for correction of deficiencies identified in developmental testing and little flexibility with individual component test schedules. The program must wait for the production of low-rate initial production (LRIP) vehicles before verifying most corrective actions.

### System

- The M109 FoV PIM consists of two vehicles, the Self-Propelled Howitzer (SPH) and Carrier, Ammunition, Tracked (CAT).
- The M109 FoV SPH is a tracked, self-propelled 155 mm howitzer designed to improve sustainability over the legacy



- M109A6 howitzer fleet. The full-rate production howitzers will have a newly designed hull, modified Bradley Fighting Vehicle power train and suspension, and a high-voltage electrical system. Operated by a crew of 4, the howitzer is capable of achieving ranges of 22 kilometers using standard projectiles and 30 kilometers using rocket-assisted projectiles.
- The M109 FoV CAT supplies the howitzer with ammunition. The full-rate production ammunition carriers will have a common chassis with the SPH. The ammunition carriers are designed to carry 12,000 pounds of ammunition in various configurations and a crew of 4 Soldiers.
- The Army intends to employ the M109 FoV as part of a Fires Battalion in the Armored Brigade Combat Team and Artillery Fires Brigades with the capability to support any Brigade Combat Team.
- The Army plans to field 580 sets of the M109 FoV with full-rate production vehicles beginning in FY17.

### Mission

Field Artillery units will use the M109 FoV to destroy, neutralize, or suppress the enemy by providing massed and precision indirect fire effects in support of maneuver units in multiple levels of conflict to include major combat operations and irregular warfare.

### Major Contractor

BAE Systems – York, Pennsylvania

### Activity

- In 1QFY12, PIM completed Phase I government developmental testing with five prototype howitzers and two prototype CAT platforms. Phase I SPH testing at Yuma Test

Center, Arizona, included five RAM missions (firing 223 rounds and moving 17.4 miles per firing mission – equivalent

to 1 combat day at the Paladin operational tempo), firing performance tests.

- Testers at the Aberdeen Test Center, Maryland, conducted Phase I testing of both vehicles to determine compliance with performance specifications. A 2,400-mile demonstration with the CAT was terminated early because of a transmission failure.
- In 2011, DOT&E raised concerns regarding the M109 FoV force protection and survivability requirements. As a result, the Army improved the systems' ballistic vulnerability requirements, and OSD directed the Army to design, develop, and test an underbelly kit to address operationally-relevant underbody blast threats.
- OSD also directed the Army to characterize the expected impact of the objective-level underbelly kit on howitzer performance and vehicle RAM by integrating such a kit into the PIM program's development and testing, and planned Production Qualification Testing.
- DOT&E approved the PIM Test and Evaluation Master Plan on March 5, 2012.
- Prototype SPHs completed refurbishment in June 2012, and entered Phase II government developmental testing, which completes production prove-out testing with prototype vehicles. Phase II included an additional 10 RAM missions using the Heavy Brigade Combat Team operational tempo, the logistics demonstration, and software verification. Phase II completed in mid-October 2012.
- Testing to characterize the protection provided by M109 FoV armor configurations began in August 2012 and is scheduled to continue through the end of the calendar year.
- The Army has scheduled a PIM Limited User Test for October 31 through November 8, 2012, to support a Milestone C decision in June 2013. The IOT&E is scheduled for 4QFY16.

## Assessment

- The current program is schedule-driven, with limited time for correction of deficiencies identified in developmental testing and little flexibility in schedules for individual tests. Most corrective actions must wait for testing with LRIP vehicles to verify the corrective action.
- The howitzer reliability estimate from Phase I RAM missions, 45 hours MTBSA, is the initial point on a reliability growth

curve designed to grow vehicle reliability above the 62-hour MTBSA needed to meet the reliability requirement.

- As Phase I RAM testing progressed, vehicle discrepancies increased as PIM subsystems had problems withstanding repeated gun shock. Legacy subsystems, including the Paladin Digital Fire Control System (PDFCS), demonstrated fewer gun-shock generated discrepancies.
- The PDFCS experienced frequent failures attributed to the Muzzle Velocity Radar System (MVRS). A software modification corrected a timing problem between MVRS and PDFCS, which is believed to have caused those failures.
- In Phase I testing, the PIM prototype SPH demonstrated the ability to conduct conventional fire missions, and verify compatibility with current 155 mm ammunition. In early testing with the initial transmission, the SPH failed to meet the climbing requirement. Subsequent testing has not demonstrated the ability to meet this requirement with confidence using correct fluid levels per the Technical Manual.
- Vehicle deficiencies were identified during Phase II RAM testing with the automotive subsystems of the SPH. These problems prevented the vehicle from conducting required short-duration survivability movements in a timely manner.
- After the critical design review, the program manager identified a number of corrective action, producibility, and obsolescence (CPO) engineering changes to the PIM design that will be implemented between LRIP and the IOT&E. The schedule for development, test, and implementation of those CPO changes is high-risk and challenging.

## Recommendations

- Status of Previous Recommendations. This is the first annual report for this program.
- FY12 Recommendations. The Army should:
  1. Provide an LRIP-configured prototype as early as possible to continue characterizing armor performance, address critical ballistic vulnerability data voids, and provide time for implementation of corrective actions before entering full-up system-level testing.
  2. Ensure that CPO changes are fully qualified in system-level testing rather than relying solely on component-level qualification before implementing them in the LRIP vehicles scheduled for the IOT&E.